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Heavy metal concentration in surface water samples of river Yamuna in Yamunanagar (Haryana), India

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ABSTRACT

Heavy metal concentration was determined in water samples of river Yamuna flowing through Yamunanagar. Three sampling stations were selected: Station Y1 at the upstream of the river before the influx of effluents, Station Y2 at the point of influx and Station Y3 at 5 kilometres downstream from station Y2. Six heavy metals were analysed seasonally during the study period, viz., lead, cadmium, nickel, cobalt, copper and zinc from the water samples. The results showed that Pb, Cd, Ni, Cu and Zn were present in recordable concentrations while Co was present in traces at all the stations. Maximum concentration was observed for zinc whereas minimum concentration was observed for nickel in river water at different stations. However, the values were within the permissible limits (WHO, 1993) except for Cd.

Keywords: Contamination, Heavy metals, Industrial Pollution, River Yamuna

Abbreviations: S.D.- standard deviations, CV- coefficient of variations, BOD- biochemical oxygen demand, NPP & GPP- net & gross primary productivity.

1. INTRODUCTION

The escalating heavy metal concentration in aquatic system is of growing concern in India and worldwide. Metals are introduced into aquatic system as a result of the weathering of rocks and soils from volcanic eruptions and from several human activities, involving the mining processing and uses of metals and industrial materials that contain metal contaminants (Marr and Creasser, 1983; Gutenmann et al., 1988). Heavy metals constitute one of the most dangerous groups because of their persistent nature, toxicity, tendency to accumulate in organisms and undergo food chain amplification and more still, they are non-degradable (Fufeyin and Egborge, 1998; Enuneku et al., 2013). The input of toxic material caused disturbances in the aquatic environment. The industrial belt of Haryana state in India is mainly situated along the north-eastern part of the state along the river Yamuna. The waste from these industries, agricultural runoff and the drains carrying municipal sewage of the cities enter into the river and affect its water quality. Some studies have been undertaken to assess the water quality of river Yamuna (Malhotra et al., 2014; Bhatnagar et al., 2013; Chopra et al., 2012) in our laboratory. However, studies dealing with heavy metal analysis of Yamuna River with special reference to industrial pollution are very scanty. Therefore, this present study has been undertaken to evaluate the water quality of river Yamuna in Yamunanagar in terms of heavy metal contamination. The results obtained are useful to the authorities and the other stakeholders.

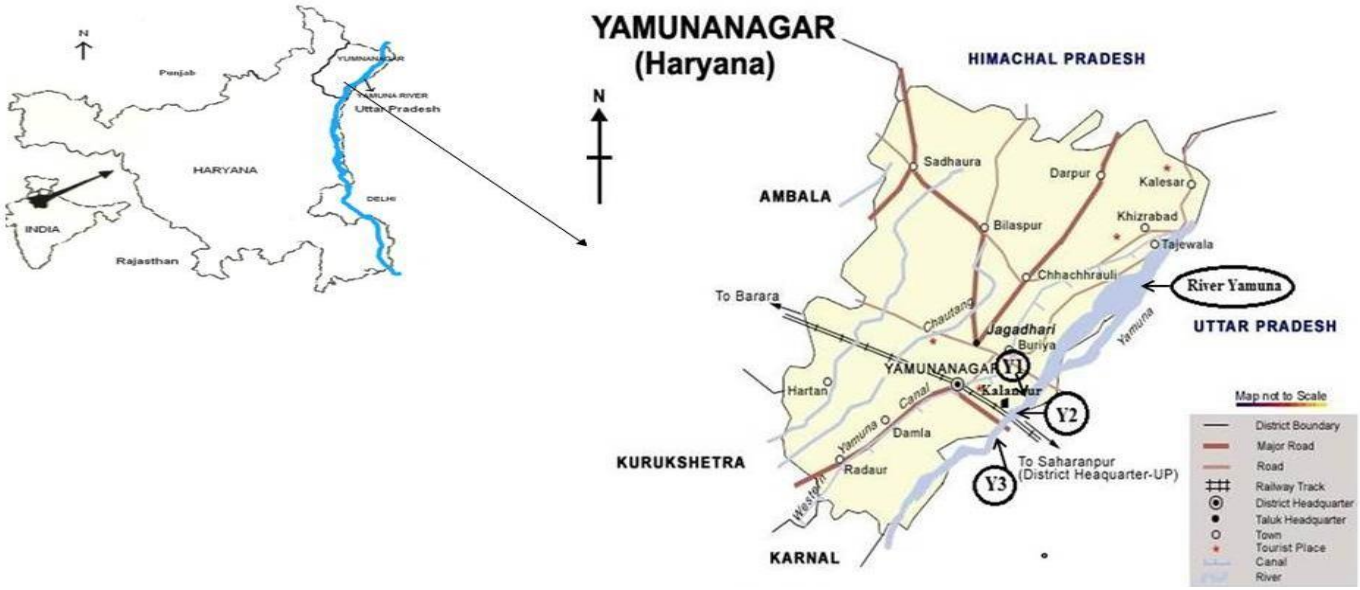

Figure 1
Map of Haryana showing Yamuna River and district Yamunanagar with selected stations

2. MATERIALS AND METHODS

Three sampling stations Y1, Y2 and Y3 were selected along the river stretch to perform practical aspects. Station Y1 is located near the village Kalanaur in district Yamunanagar at the upstream of the river, without any industrial discharge. This point is bathing and washing centre for the people of the village. StationY2 is stationed 4-5 Kms downstream from station Y1. Here the effluents channels carrying industrial effluents via. maskaranala joins the river (Figure 2). Station Y3 point is stationed 5 Kms downstream from the station Y2 (Figure 1). For the Heavy metal analysis, water samples were preserved in refrigerator, after acidification with HNO3 to Ph 2.0. The concentration of different heavy metals was estimated on atomic absorption spectrophotometer (Model Analytik Jena MPE 60 Zeenit 700P).

3. RESULTS AND DISCUSSION

Heavy metals are very toxic because, as ions or in compound forms, they are soluble in water and may be readily absorbed into aquatic organisms. The concentration of heavy metals was influenced significantly by the seasons. Heavy metals viz., lead, cadmium,

nickel, cobalt, copper and zinc were analysed seasonally during the study period are shown in the Table 1 and Figure 3. The values of lead were high during summer and post monsoon whereas low during monsoon. The concentration of Pb showed an increasing trend from station Y1 to Y2 and then decreased at station Y3 (Figure 3). This may be due to reduction in the flow of water due to high rate of evaporation during summer. Similar observations were also reported by Anju et al. (2011). Lead is hazardous to health as it accumulates in the body and affects the central nervous system (Adeyeye, 1994). However, the values were within permissible limits of World Health Organisation (1993). The concentration of cadmium was found maximum during winter at station Y1 and minimum during monsoon at Y2. Cd depicts a decreasing trend from station Y1 to Y2 and thereafter increased at station Y3 (Figure 3). This may be due to high anthropogenic activities at stations Y1 and Y3. The values of cadmium were higher than the permissible limit (5 µg L-1) suggested by WHO (1993). Concentration of copper was high during post monsoon at station Y1 whereas, during winter and monsoon seasons at Y3. The values depict a decreasing trend from station Y1 to Y2 and then further increased at station Y3 (Figure 3). Higher values of copper may be due to release through the domestic activities such as human wastes flushed through the toilets, washing and bathing water etc. Copper in the dissolved form is potentially very toxic to aquatic animals and plants, especially to young life-stages such as fish larvae. The toxicity of copper is however greatly reduced when it is bound to particulate matter in the river water and when the water is hard.

Figure 2
Photographs of river Yamuna showing stations Y1: upstream of the river, Y2 (A): middle reach of the river where effluents joins the river, Y2 (B): station Y2 showing mixing of dirty drain with Yamuna river, Y3: 5kms downstream from station Y2 after influx of effluents

The maximum concentration of zinc was recorded during monsoon at station Y1 and during post monsoon at station Y2 and Y3 whereas minimum concentration observed during summer at station Y1 (Figure 3). Bordoloi et al. (2000) have reported that metals deposited in the sediments come out during heavy rainfall and flow into river water system. Roberto et al. (2008) have also reported that rain water infiltrated the soil and underlying geologic formations and dissolve metals. The mean values of zinc increased from station Y1 to Y2 and then further decreased at station Y3. The values were recorded with in the permissible limit (WHO, 1993). Nickel was found in maximum concentration during summer at stations Y1 and minimum during monsoon at stations Y2 (Figure 3). The mean values of nickel remained same from station Y1 to Y2 and then decreased at station Y3. However, the values were within the permissible limit of WHO (1993).

The results showed that Pb, Cd, Ni, Cu and Zn were present in recordable concentrations at all the stations while Co was present in traces at all the stations. Similar results have been shown by Kulshrestha et al. (1989) in the river Khan (India). These values were within the permissible limits (WHO, 1993) except for Cd. Soil sediments around the river areas contained humic substances which are known to act as chelating agents (Gabriel et al., 2006). These chelating agents may be responsible for the low concentration of the heavy metals studied in the river (Nwani et al., 2009). Concentration of different metals in high concentration at various stations may be due to various religious activities recorded at the bank of river. These religious activities included floral offering and inflow of oil, ash etc. in to the river by devotees.

4. CONCLUSION

The industries and public should recognize the need to monitor the concentrations in discharges and in rivers closely, to ensure that Water Quality Objectives are not exceeded. Higher values of various metals in the river water are affecting the overall ecology of the river Yamuna. So, it is necessary to treat the water of river Yamuna and to establish efficient treatment plants by the effluents.

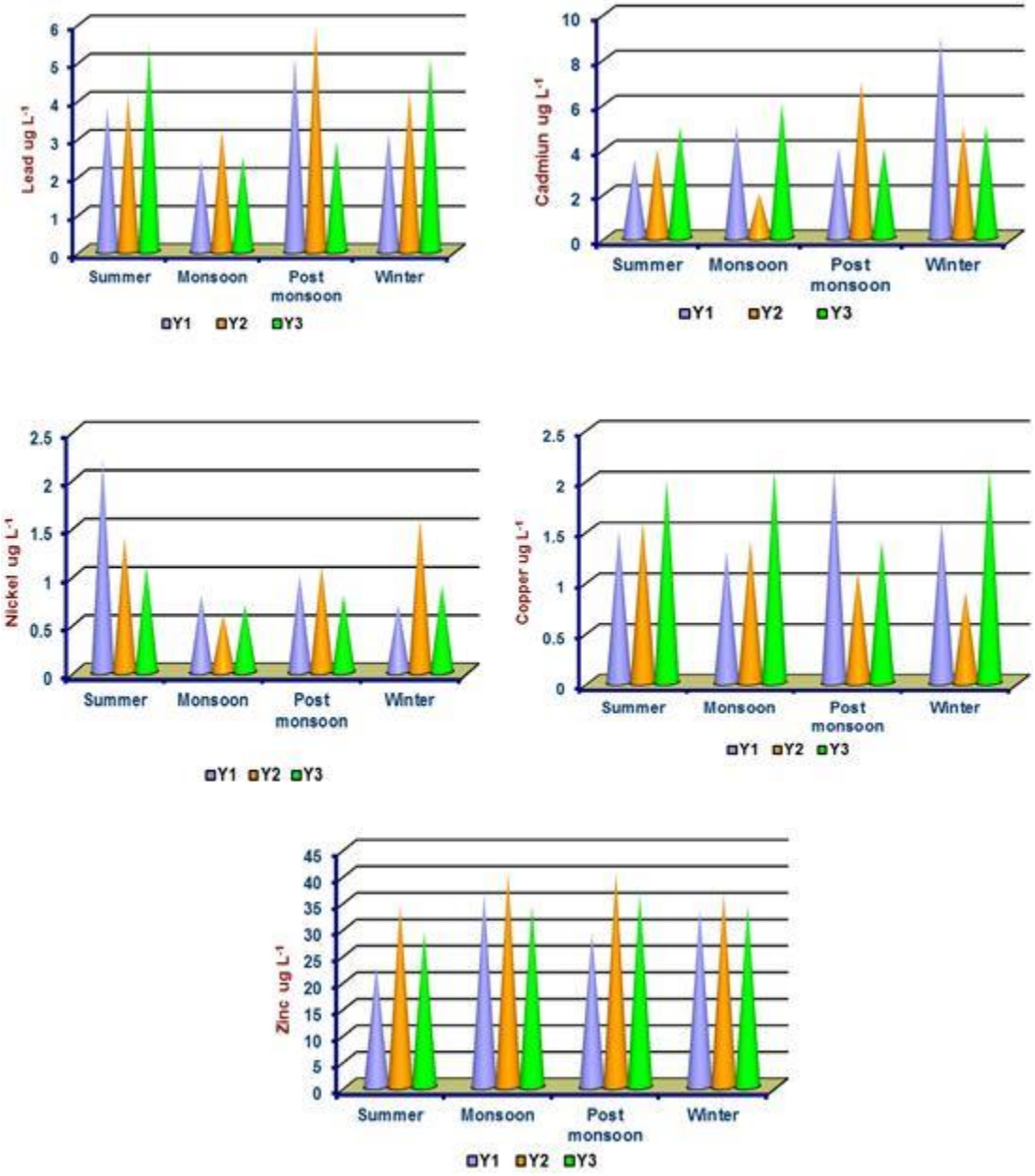

Figure 3
Seasonal variations in heavy metals of river Yamuna at various stations

Table 1
Heavy Metals (µg L-1) in water samples of river Yamuna at various stations

	Y1				Y2				Y3				WHO, 1993 Standard (µg L^{-1})
	S	M	PM	W	S	M	PM	W	S	M	PM	W	
Pb	3. 8	2. 4	5. 1	3. 1	4. 1	3. 2	5. 9	4. 2	5. 4	2. 5	2. 9	5. 1	10
Cd	3. 5	5. 0	4. 0	9. 0	4. 0	2. 0	7. 0	5. 0	5. 0	6. 0	4. 0	5. 0	5
Ni	2. 2	0. 8	1. 0	0. 7	1. 4	0. 6	1. 1	1. 6	1. 1	0. 7	0. 8	0. 9	100

Co	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	-
Cu	1. 5	1. 3	2. 1	1. 6	1. 6	1. 4	1. 1	0. 9	2. 0	2. 1	1. 4	2. 1	-
Zn	22.7	36.4	29.0	33.6	34.2	40.4	40.6	36.5	29.2	34.1	36.4	34.1	3000

Where, S = Summer M = Monsoon, PM = Post Monsoon W = Winter

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